

Jet reconstruction with charged tracks only

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Motivations

In CMS charged tracks are measured better than calo objects

for the transverse energy $\frac{\Delta P_T}{P_T} \cong 0.2 \cdot 10^{-3} \frac{P_T}{GeV} \oplus 0.01$

but moreover for the direction determined @IP origin

Expect the charged tracks picture of a busy multi-jet event to be 'cleaner' than the calo tower picture with more collimated true jets and less overlap interference & background

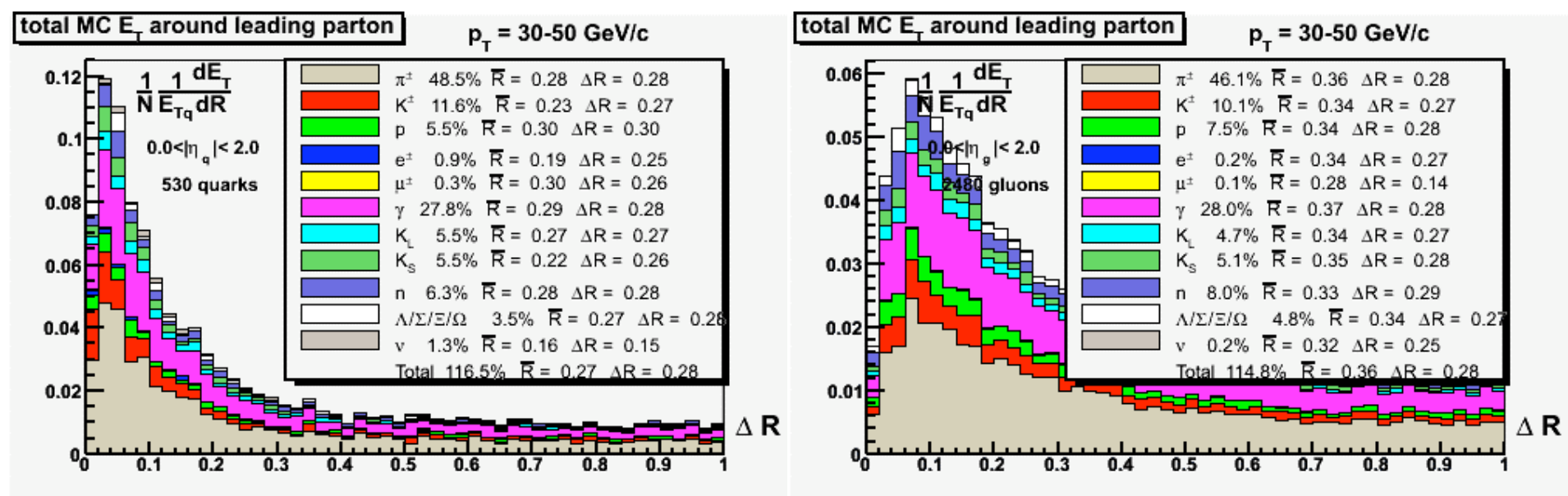
Jet finding with charged tracks only is completely independent from jet finding with calo towers and could prove a good way to find/count jets, and determine their directions

MC truth particles around partons

Focus on partons with $|\eta| < 2$

Look at QCD events with $0 < \hat{p}_T < 3\text{TeV}$

Fraction of leading parton ET carried by MC truth particles



Visible charged particles carry ~60% of parton ET

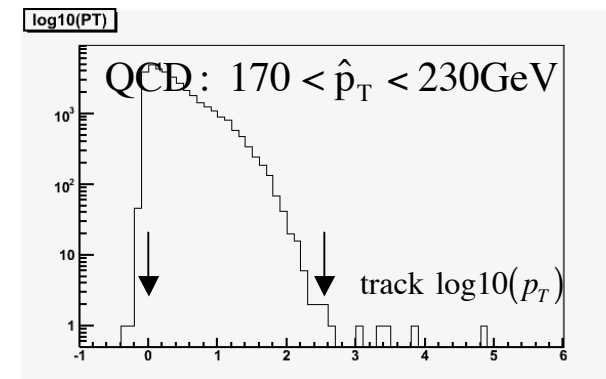
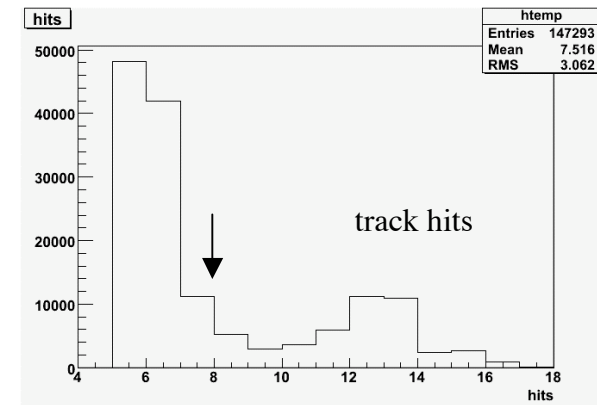
Selection of reco charged tracks

$$\text{hits} \geq 8$$

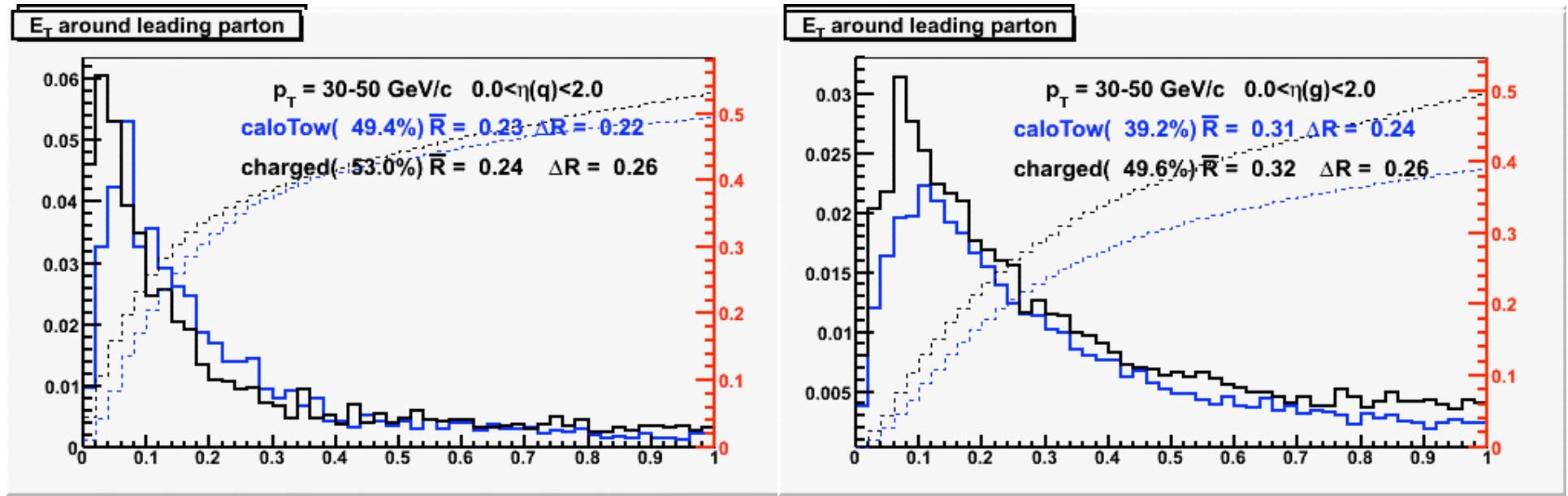
$$\text{fit } \chi^2/\nu < 100$$

$$1\text{GeV} < p_T < 500\text{GeV}$$

Can find reco charged tracks with
pt=1,10,100 TeV->problematic!
In MC truth tracks pt>500GeV are very rare
e.g. they represent 0.8% of the total ET
in a 1TeV QCD event



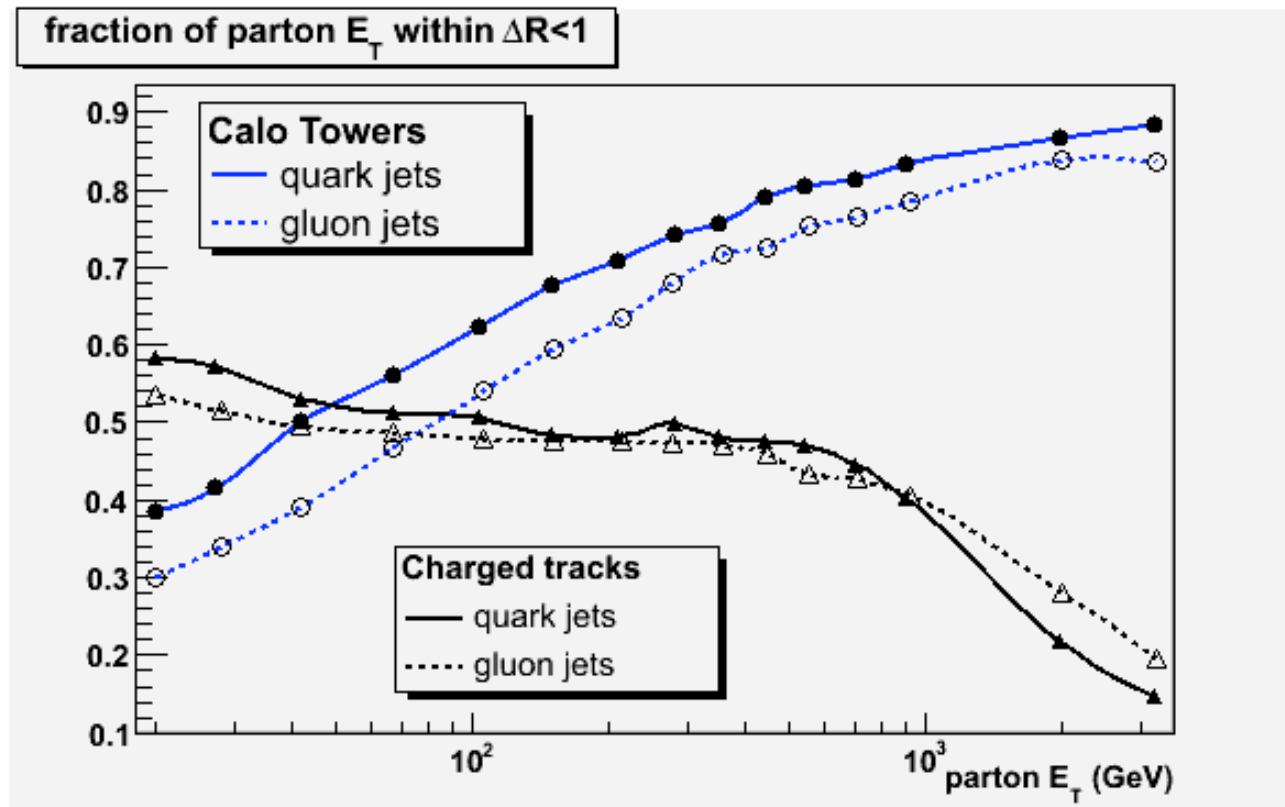
Charged tracks & calo towers around the parton axis



Within the $R < 0.1$ core the charged tracks are more collimated !

Very low yield of total charged ET within high energy jets ($\sim 1 \text{ TeV}$)!

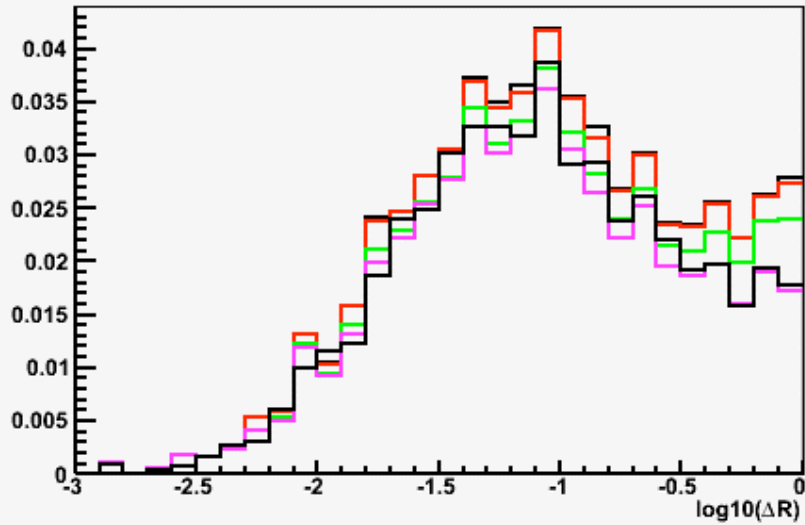
Charged & Calo Jet response



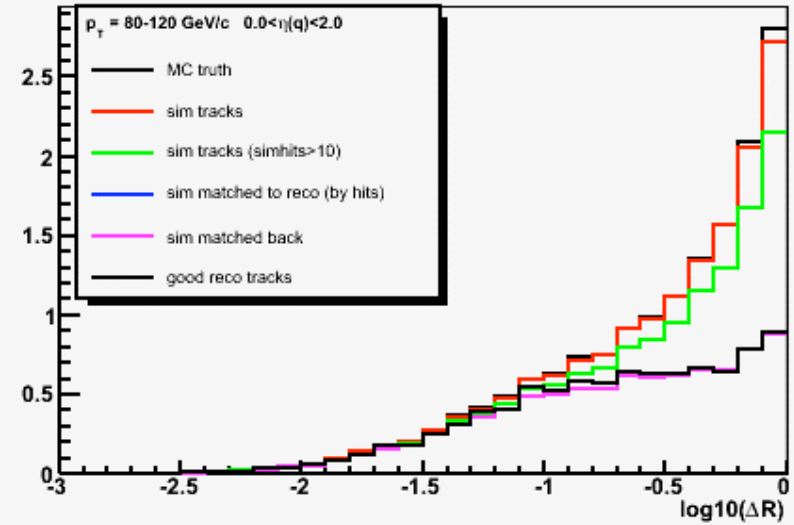
Charged response decreases slowly in the 100GeV-1TeV range and drops for $E_T > 1\text{TeV}$

Reco Charged tracks in jets

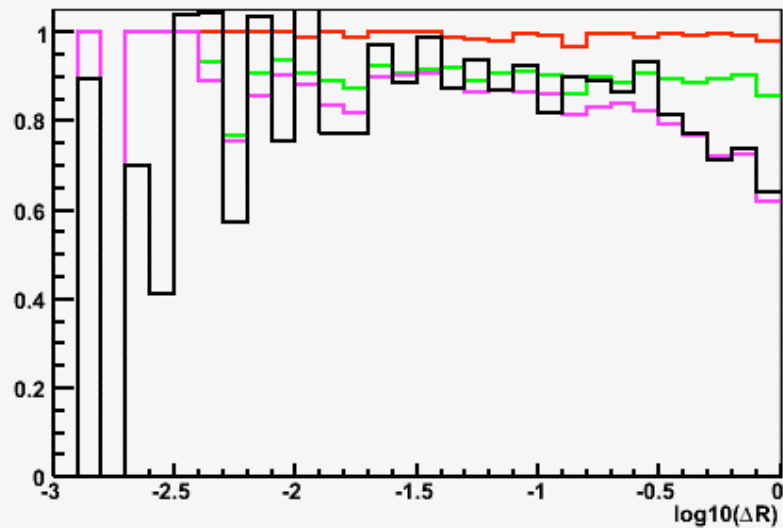
charged E_T around leading parton



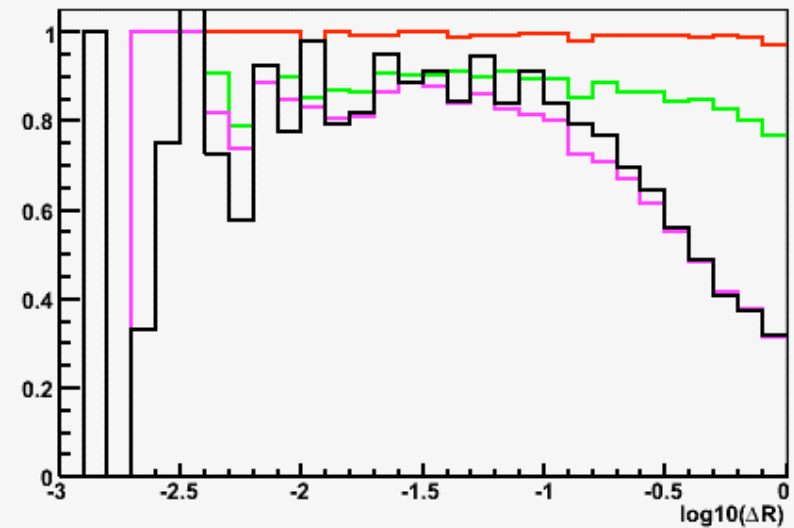
charged # around leading parton



tracks E_T eff



tracks eff



Charged tracks reco in jets

Efficiencies to reconstruct charged tracks in the core of energetic jets drop down to 20% on the jet axis

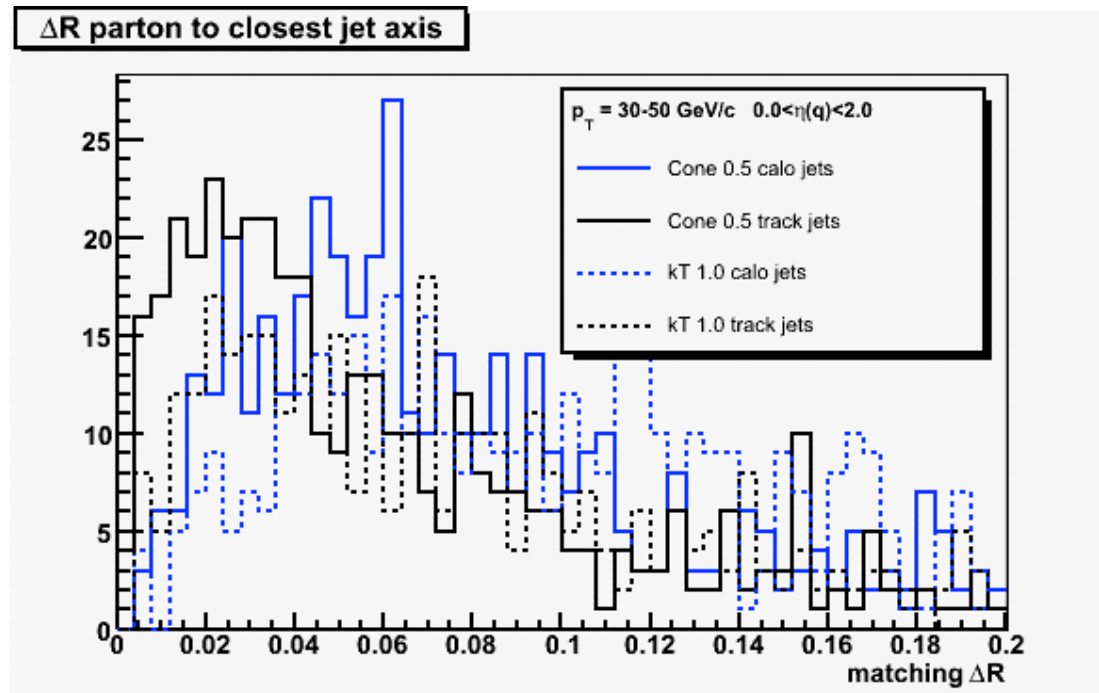
The tracks that are not (well) reconstructed are high momentum tracks close to each other that share hits in the inner layers of the tracker

The situation should improve implementing DAF (Deterministic Annealing Filter) or MTF (Multi Track Filter) in the tracks reconstruction ...

Jets with charged tracks only

now make jets (icone,kT) with
good Charged Tracks and
compare to Calo Towers jets

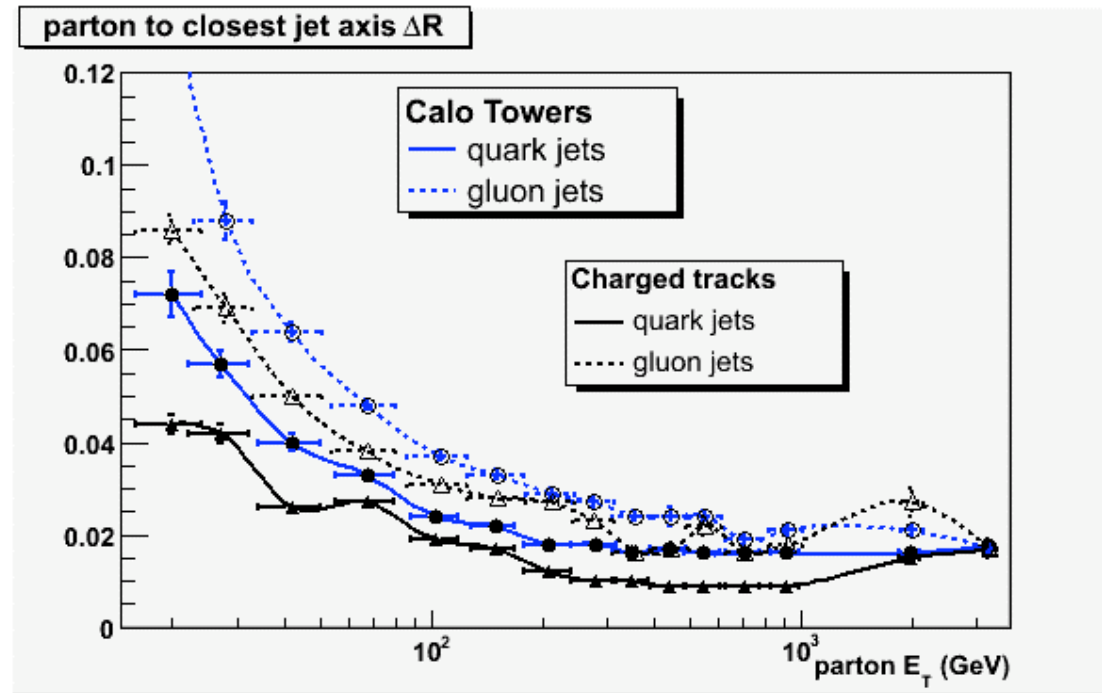
Jet axis to parton direction



Matching within $R < 0.3$ is
80-85% efficient for charged jets
85-90% efficient for calo tower jets

$$\text{fit to } f(x = \Delta R) = Ax \exp\left(-\frac{x}{x_0}\right) \text{ to find maximum } (x = x_0)$$

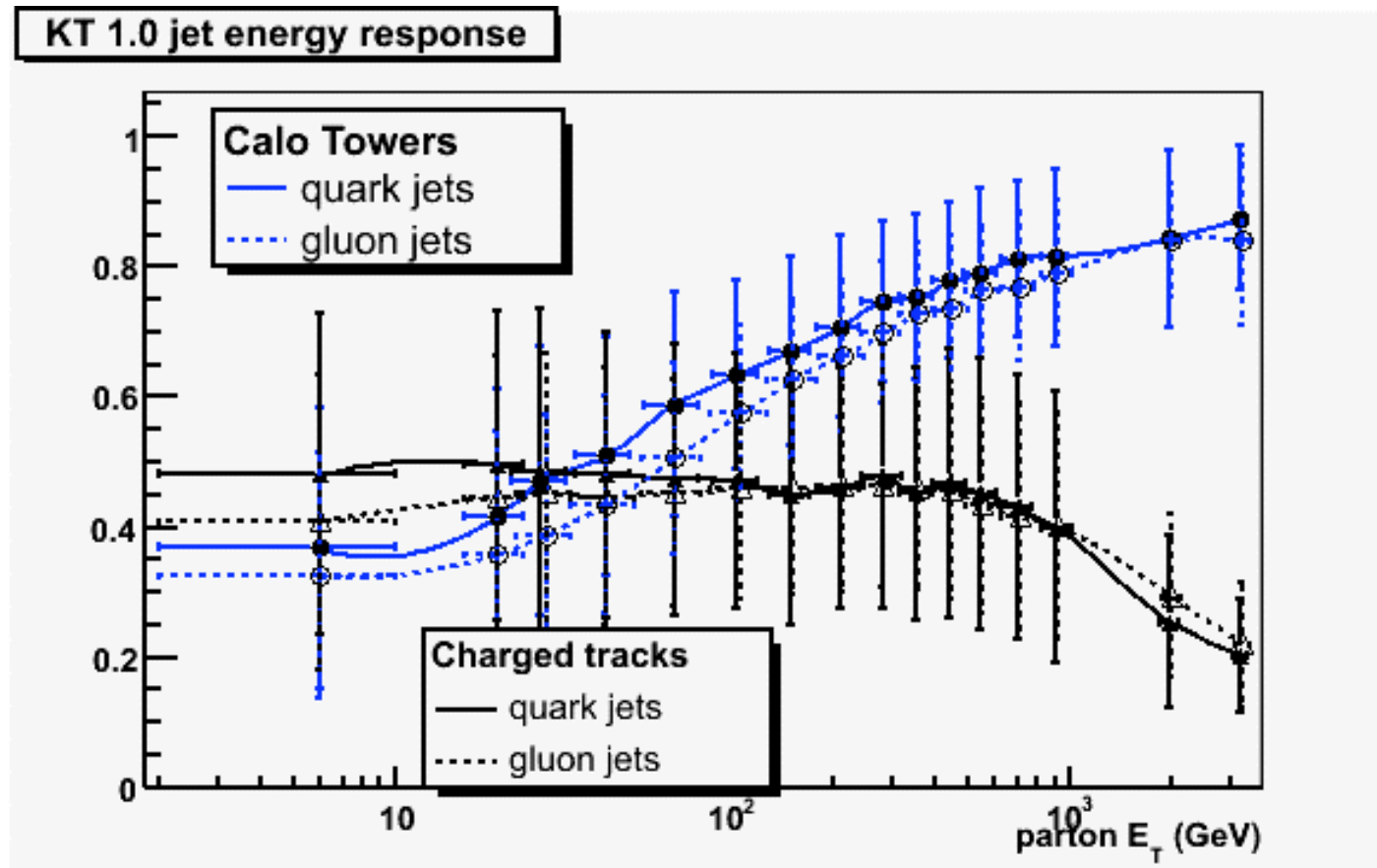
Jet angular resolution



0.5 iterative cone

Charged tracks jet angular resolution ~ 1.5 times better than calo

Jet energy response



Jet within $R < 0.3$ of parton axis

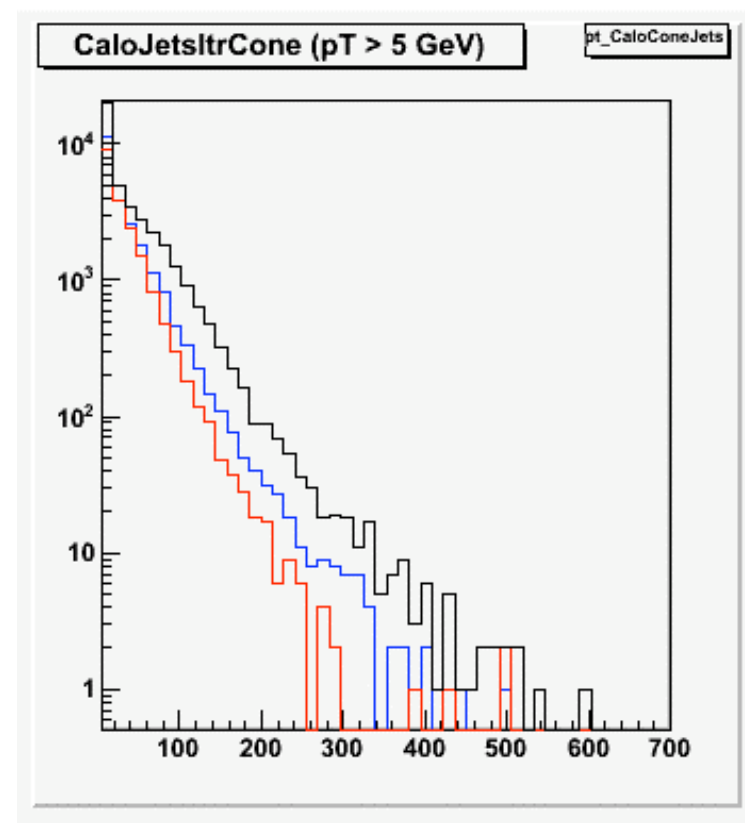
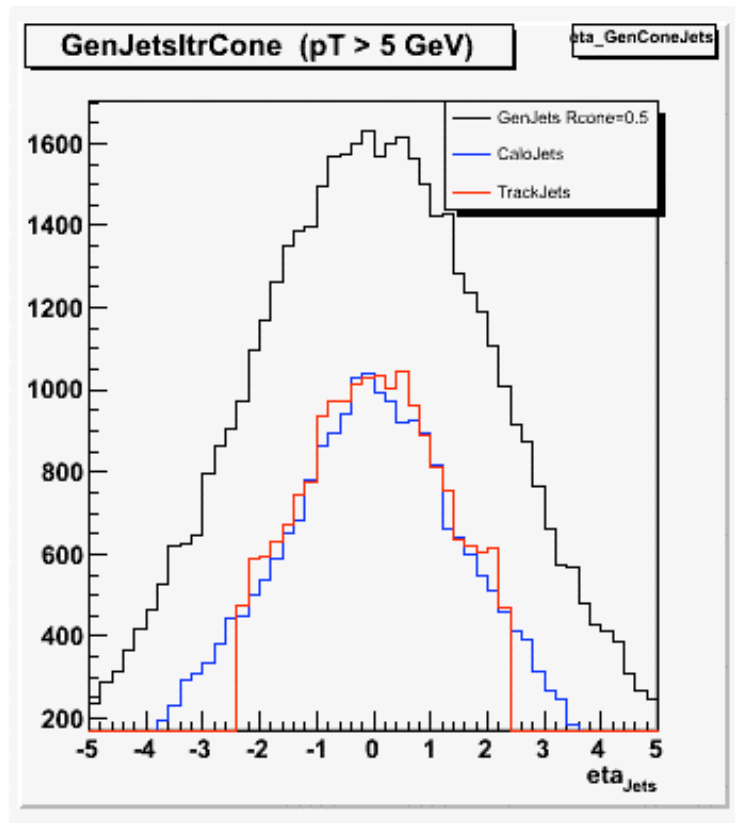
Jet finding in fully hadronic $t\bar{t}$

Select hadronic decays $t\bar{t} \rightarrow b\bar{b}q\bar{q}q\bar{q}$ (45% of total)
with all six quarks within $|\eta_q| < 2$ (15% of total)

Make Iterative Cone jets with CaloTowers or good tracks
with $R = 0.3 - 0.5 - 0.7$

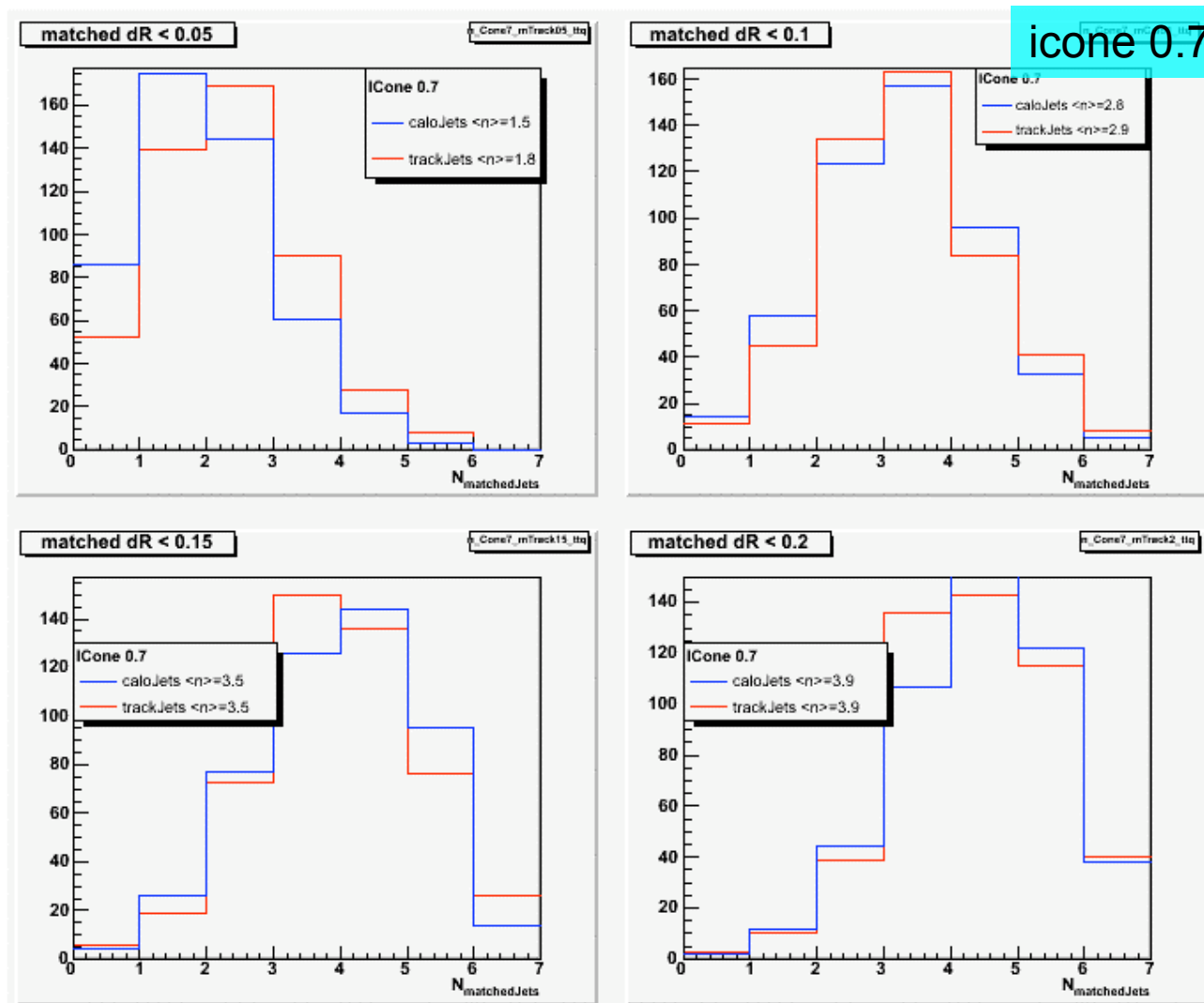
Check how well they match the six quarks

Jets in hadronic ttbar events

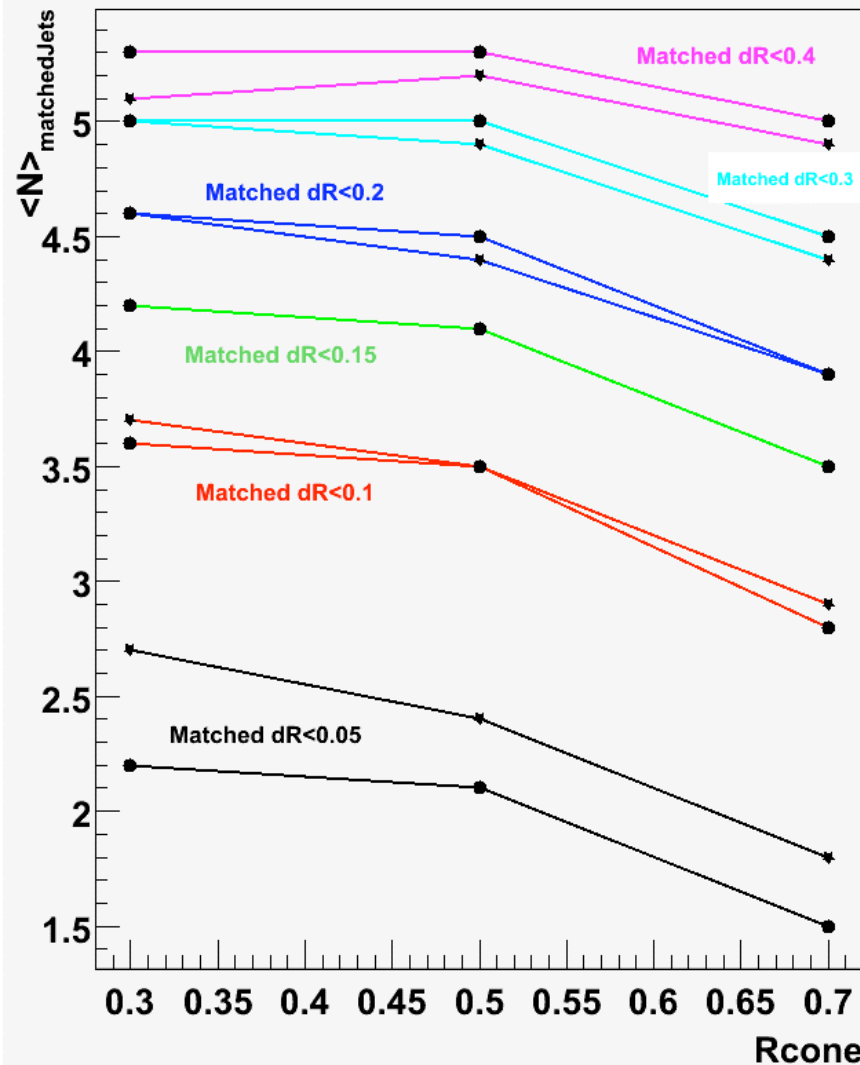


ICone 0.5 GenJets CaloJets TrackJets in ttbar events

num of Jets matched to the quarks



Jet matching efficiencies vs Rjet



★ tracks jets

● calo jets

Track jets better with very strict matching dR, else equivalent to calo jets

Outlook

Jets built with charged tracks appear to be more collimated than calorimeter jets, but only at small $dR < 0.1$ distances

The angular resolution of jets made with tracks seems quite better than with calo jets

The energy response is quite constant around 50% but drops at very high jet energies due to problems with the track finding algorithm in the jet core

Preliminary studies indicate that the efficiency of multi-jet finding with tracks is similar to calo jets

Work ahead to understand what is the best possible use of charged tracks for jet finding & reconstruction